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Evaluation of an Engelmann Spruce Beetle Trap Tree Project in Southern Utah

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INTRODUCTION

This is the first in a series of reports on an Engelmann spruce beetle trap tree project in Deer Valley on the Dixie National Forest, Utah. This trap tree project was conducted as part of a salvage sale located in the leave strips of an old timber sale in Deer Valley. Described in this report are the history of the area, methods established for the project, and the results following the first season.

The original Deer Valley timber sale was cut in the late 1960's and consisted of 33 clearcut blocks equal to approximately 1000 acres within a 2500-acre area. The sale area was composed of Engelmann spruce mixed with subalpine fir and a smaller amount of Douglas-fir. Cutting blocks were layed out in long parallel strips 5-chains wide and spaced about 5-chains apart (Figures 1 and 2). Following the completion of the original sale, spruce beetle-caused mortality of Engelmann spruce increased each year through 1971. Following this initial increase, mortality decreased in 1972 and again in 1973 and 1974. The decrease in the number of new faders in 1974 was followed by a large increase in the number of 1974 attacks.

During the spring of 1974 a salvage sale was marked in several of the old Deer Valley leave strips (Figure 2). This sale was located in a concentration of dead and currently infested trees. By fall 1974, approximately 1.2 million board feet of timber were cut and removed.

METHODS

The Deer Valley salvage sale and the increasing spruce beetle population provided an excellent opportunity to conduct a trap tree program. As a postlude to the salvage sale, an additional 550 large diameter green spruce trees were felled. These trees were scattered throughout the salvage sale area. To provide near natural conditions the trap trees were not limbed. During the flight period the trap trees provided an artificial but preferred host for the spruce beetle. During early summer following the flight period, an evaluation of attack density was conducted. Following this evaluation the trap trees were hauled to the mill.

Edge Windthrow

To determine the amount of windthrown material, the perimeter of 20 of the 33 cutting blocks of the original sale were examined. All windthrow within one chain (66 feet) of the clearcut boundaries was recorded by diameter (only trees 6 inches dbh and larger) and examined for spruce beetle activity. Only the presence or absence of spruce beetle emergence was recorded based on the presence of egg galleries and emergence holes. No attempt was made to record attack or emergence density.

Since the long axis of the cutting blocks ran generally east and west, windthrow was recorded as occurring on the north or south side of each block. No attempt was made to measure the amount of blowdown within the stand or across the end of each block. The length of only one side of each block was measured.

Trap Trees and Stumps

Of the 550 trap trees in the salvage sale area 64 were randomly selected to measure spruce beetle attack density. Beginning at dbh, two 6x12 inch plots were established at 10 foot intervals on the opposite side of the bole (Figure 3). Bark was removed from each plot and the number of spruce beetle and Ips spp. attacks (starts) were recorded. Sampling continued up the bole until both plots of a pair had no spruce beetle attacks. Also recorded were the azimith each tree was felled, the degree of exposure to the sun, and the dbh.

The same technique was used on the stumps except only one plot was established on each stump. This plot was placed vertically on the shaded (north) top edge (Figure 3). The height and top diameter of each stump was also recorded. Stumps were numbered and their location was documented so they could be resampled in 1976 to determine brood production.

Green Stand and Trend

A series of plots were distributed over the original sale area to measure the trend of the infestation in standing trees (Figure 2). Forty permanent one-half by 10-chain plots were established to record spruce beetle-caused mortality and new attacks. A variable plot (BAF 10) was established at the end of each strip plot to record green stand data. Strip plots will be resampled in 1976 and 1977 to record new attacks.

RESULTS AND DISCUSSION

The increase in spruce mortality following the original timber sale was first assumed to be the result of population buildups in the logging slash. However, Dyer (1971) found that logging slash absorbed more beetles than it subsequently produced. In addition, Dyer also found that windthrow along the forest edge produced a three-fold increase in beetles, while windthrow within a shaded stand produced an eight-fold increase.

The particular block design (linear) selected for the original Deer Valley sale provided a large area of newly exposed boundary. Along the 47 miles of boundary examined, a total of 1208 windthrown trees was tallied of which 89 per cent had been infested with spruce beetle. Assuming this material produced a three-fold increase in beetles, the windthrow along the clearcut boundaries played a substantial part in the population buildup.

To minimize the amount of exposed boundary, the area-to-boundary ratio should be as high as possible. The highest ratio is obtained by using a circle, but this shape would be highly impractical in most cases. A long rectangle gives the lowest ratio and the best compromise is obviously somewhere in between.

In the original sale area 1000 acres of clearcuts having a boundary of 53 miles had a ratio of 19 to 1. Assuming that each cutting unit was a circle the following ratios would be possible:

Block Size (acres)	Length of perimeter (miles)	Ratio acres/miles	Perimeter length for 1000 acres
500	3.1	161:1	6.2
250	2.2	114:1	8.8
100	1.4	71:1	14.0
50	1.0	50:1	20.0
25	0.7	36:1	28.0
10	0.4	23:1	44.0

For example, ten 100-acre circular blocks would have reduced the boundary from 53 to 14 miles.

The amount of blowdown was also influenced by the orientation of the cutting blocks. Of the total windthrow, 63 percent was located on the north side of the clearcut, and 37 percent on the south side.

Spruce beetle attack density in the trap trees averaged 3.2 per square foot and 5.2 per square foot in the stumps. Average attack height on the trap trees was 31 feet. The total number of spruce beetle attacks per tree was calculated from the surface area of each 10-foot bole section and the attack density for that section. Total attacks per trap tree averaged 825. However, the actual number of attacks per tree was probably higher since samples on the lateral surface of the bole tend to underestimate the attack density for the entire tree.

Based on limited data, spruce beetle attack density in standing green trees is usually less per unit area than in felled or windthrown trees, while the height of attack is about the same. Although no attack data for standing green trees are available from the sale area, but assuming the above relationship holds true, the number of beetles removed from the salvage area in the trap trees had the potential of infesting at least as many green trees. Depending on the amount of windthrow throughout the stand and the population pressure from other areas, this potential may or may not have been realized.

Sun exposure of each trap tree was empirically rated on a scale of one to five. Average attack density by exposure class follows:

1.	Full shade	No trees recorded
2.	Mostly shade	4.2 attacks/Sq. ft. (12 tree average)
3.	Part shade & part sun	3.7 attacks/Sq. ft. (28 tree average)
4.	Mostly sun	2.2 attacks/Sq. ft. (24 tree average)
5.	Full sun	No trees recorded

This trend of increased attack density with an increase in shade is consistent with the beetle's preference for shaded windthrow.

The residual green stand was composed of a near even mix of Engelmann spruce (53.8 trees/acre) and subalpine fir (42.3 trees/acre) plus a small amount of Douglas-fir (3.3 trees/acre) and a trace of limber pine (0.9 trees/acre). Cumulative spruce mortality prior to 1974 was 4.55 trees per acre. The spruce beetle killed 0.55 trees per acre in 1974 and attacked another 0.90 trees per acre in 1975. Stand structure and composition are summarized by diameter in Table 1. New attacks will be recorded in 1976 and again in 1977.

RECOMMENDATIONS

To minimize windthrow along clearcut boundaries, the area-to-boundary ratio should be as large as possible. Where terrain permits, clearcut blocks should be layed out in an array of near circular units. Relatively large blocks are preferred over small ones. Spruce stands disturbed by clearcutting will usually experience blowdown until the stand can stabilize (2 or 3 years). Provisions should be made during the initial planning of a sale to remove any windthrow for 2 or 3 years following the sale. If the spruce beetle population is high, trap trees could be used, both to decrease the bark beetle hazard and to provide additional sale volume.

REFERENCES

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Knight, F.B. 1960. Measurement of engelmann spruce beetle populations. Ecology. 41:249-252.

Stipe, L.E. 1975. Work plan, estimating the effectiveness of the spruce beetle trap tree program in Deer Valley, Dixie National Forest. USDA, Forest Service, Region 4, S&PF., 3p.

APPENDIX

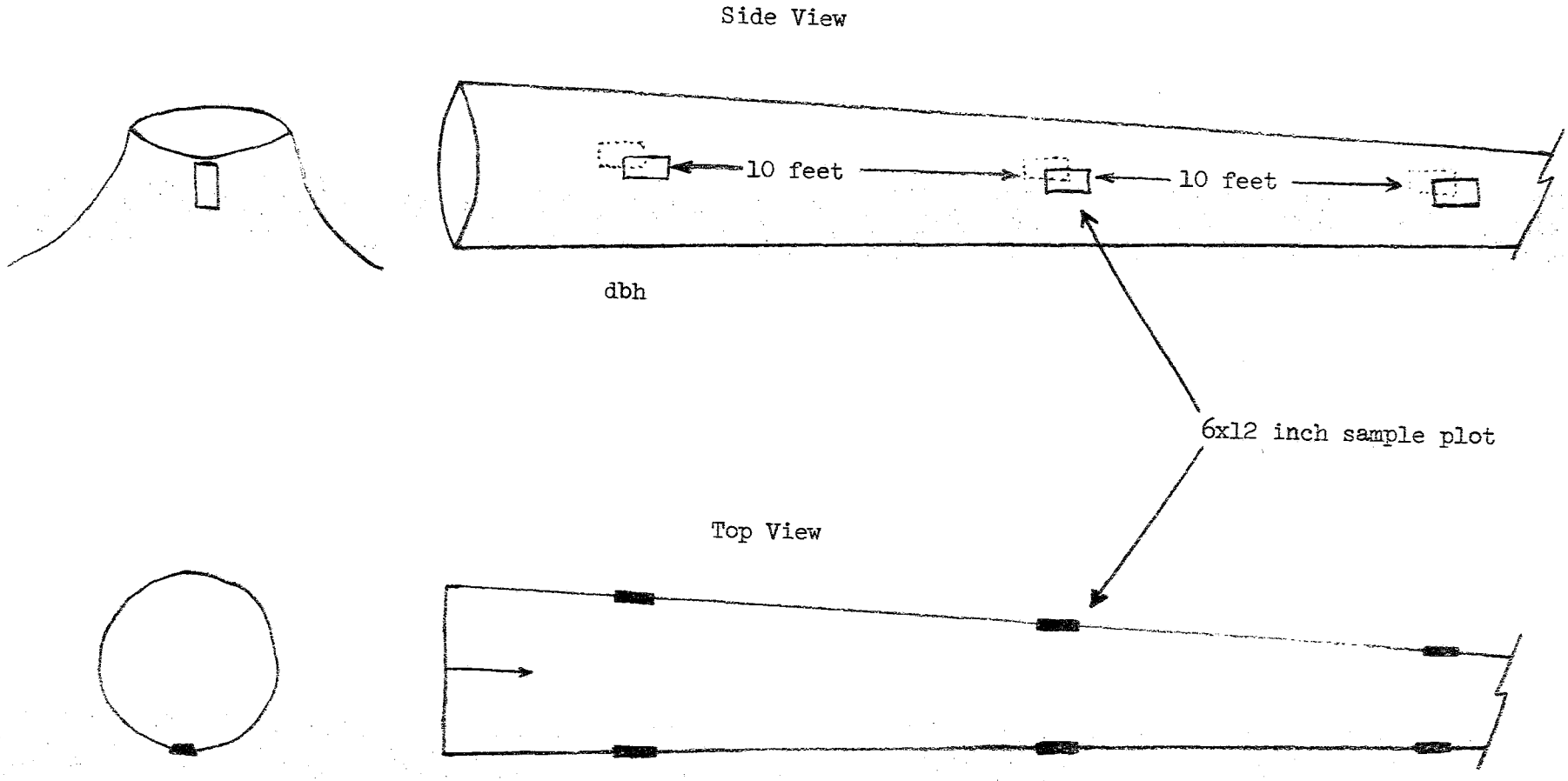

Figure 3. Sample plot layout on trap trees and stumps.

Figure 1. Aerial oblique view of the Deer Valley Sale Area on the Dixie National Forest, 1975.

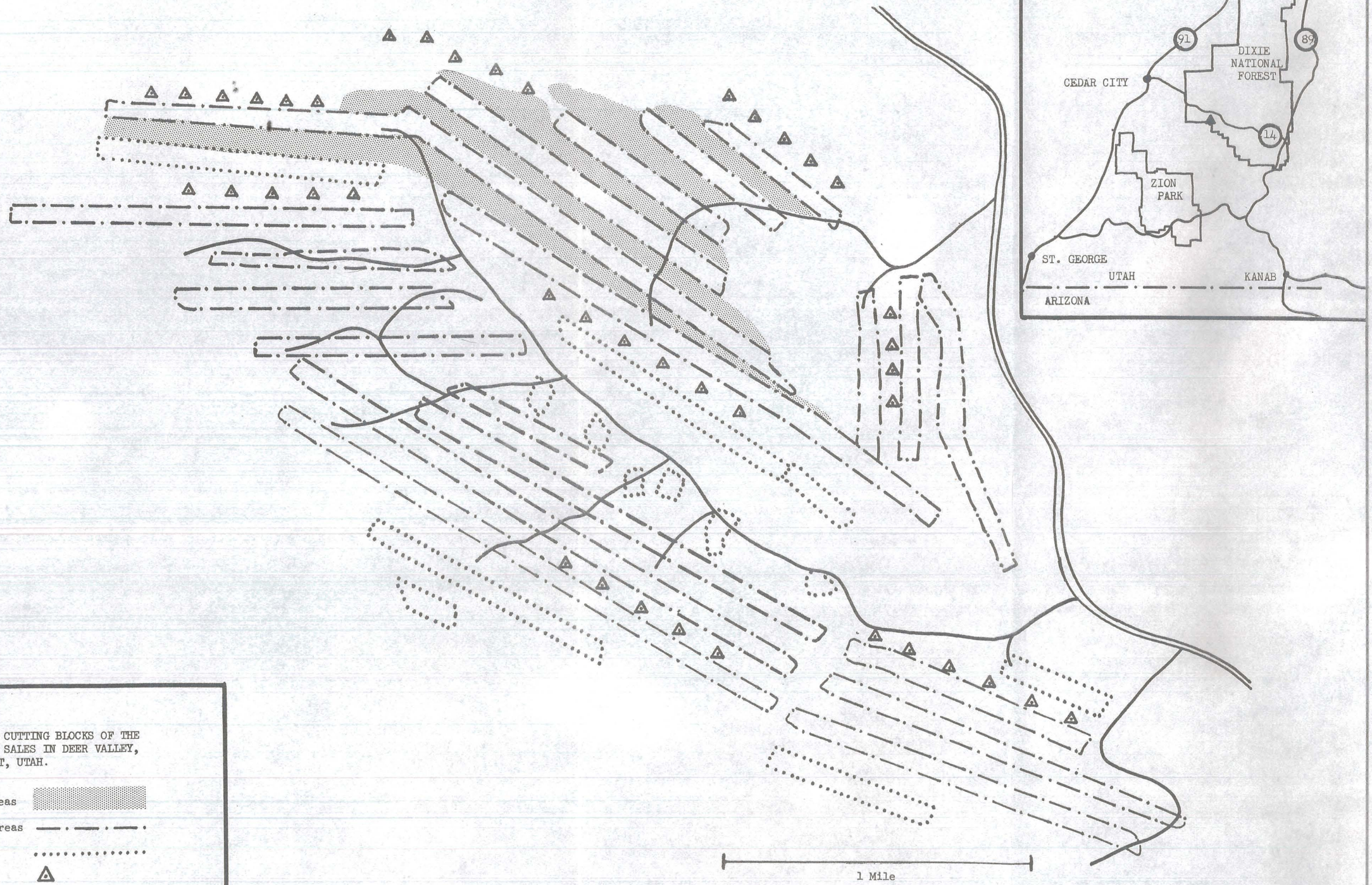

FIGURE 2. LAYOUT OF CUTTING BLOCKS OF THE ORIGINAL AND SALVAGE SALES IN DEER VALLEY, DIXIE NATIONAL FOREST, UTAH.

1974 salvage sale areas

Edge blowdown data areas

No data collected

Trend plots

DBH	Live Spruce	1975 Attacks	1974 Attacks	Snags	Subalpine fir	Douglas-fir	Limber Pine
7	9.4	.05	.05	.10	3.7		
8	4.3	--	.10	.10	8.6		
9	--	--	--	.05	10.2		
10	1.8	--	--	.05	1.8		
11	4.5	.10	--	.10	5.3		0.8
12	2.5	--	--	.10	1.9	0.6	--
13	3.8	.05	--	.35	2.2	0.5	--
14	2.8	.05	--	.20	2.8	--	--
15	2.0	.05	--	.25	1.2	0.4	--
16	3.2	.05	--	.25	1.8	0.3	--
17	2.9	.05	.05	.20	1.0	--	--
18	3.4	--	--	.30	0.6	0.8	--
19	2.8	.05	.05	.15	0.3	--	--
20	1.1	.10	--	.20	--	--	--
21	0.4	.05	--	.25	0.4	--	--
22	1.7	.05	.05	.15	--	0.6	--
23	1.4	.15	--	.25	0.2	--	--
24	1.3	.05	.05	.30	0.2	--	--
25	1.0	--	.05	.30	--	--	--
26	0.3	--	--	.35	0.1	--	--
27	0.8	--	.10	.05	--	--	--
28	0.6	--	--	.05	--	--	--
29	0.5	.05	--	.10	--	--	0.1
30	0.4	--	--	.05	--	0.1	--
31	0.3	--	--	--	--	--	--
32	0.1	--	--	--	--	--	--
33	0.1	--	--	.05	--	--	--
34	0.2	--	--	--	--	--	--
35	--	--	--	--	--	--	--
36	0.1	--	--	.10	--	--	--
37	--	--	--	.05	--	--	--
38	--	--	--	--	--	--	--
39	--	--	--	--	--	--	--
40	0.1	--	--	--	--	--	--
Total	53.8	0.90	0.55	4.55	42.3	3.3	0.9 - 105.75

Table 1. Stand composition, structure, and mortality by diameter in trees per acre in the Deer Valley sale area, Dixie National Forest, Utah.